

SpaceWire Plug-n-Play and CCSDS SOIS: How do they fit together?

***SpaceWire Working Group Meeting 13
ESTEC, Noordwijk, NL
14-15 September 2009***

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CCSDS SOIS Background

- CCSDS Spacecraft On-board Interface Standards (SOIS) is a Work Group (WG) that has defined the services for 2 of the 3 defined layers defined by SOIS (documented in a series of CCSDS Red Books)
 - Subnetwork and the application support layer has service definitions
 - Transport layer has no services defined
- The Subnetwork SOIS defined services are requirements that feed into the SpaceWire (SpW) WG to steer it's focus
 - e.g., SpW-Real Time (RT) is an effort to implement the Quality of Services (QoS) defined in the SOIS Green book
- SOIS Plug-n-Play (PnP) services defined by SOIS include device discovery (at the subnetwork layer) and services at the application support layer
 - Device Enumeration
 - Device Virtualization
 - Etc.

AFRL ORS Background

- Air Force Research Lab (AFRL) office of Operational Responsive Space (ORS) has been working on implementing their approach for PnP and have defined an architecture
 - implemented on PnPSat – demonstration not to be launched
- Some portions of their implementation approach may be useful to SOIS application support services
 - specifically Device Description, i.e., eXtensible Transducer Electronic Datasheet (XTEDS)

Current CCSDS SOIS Work

- Service Red Books for Sub network WG are complete and
- WG is now focused on defining PnP architecture models for the application support layer
- These architectures are based upon defining a device description for on-board components, i.e., an Interface Control Document (ICD)
- There are two choices being considered for device description
 - IEEE 1451 - Transducer Electronic Datasheet (TEDS) and
 - eXtensible Transducer Electronic Datasheet (XTEDS)

AFRL ORS-CCSDS SOIS Collaboration

- AFRL has made XTEDS public release (as of April 2009) and has presented their PnP concept to the SOIS WG in April 2009
 - IEEE 1451 TEDS was also presented & demonstrated
- AFRL ORS has requested that CCSDS SOIS take the lead to standardize XTEDS
- XTEDS developer (Ramon Krosley, Design Net Inc.) has been made available by AFRL to work with SOIS WG to understand and evaluate XTEDS

What is XTEDS

- An XML Schema for describing certain aspects of on-board interfaces
 - Interfaces – software or hardware
 - Some location info
 - Messages (outgoing, incoming (cmds), and combos)
 - Variable in those messages (i.e. “parameters”)
 - User defined flags (Qualifier)
- Stored on device
- Very small and simple

NASA/GSFC Goal for PnP

- Provide ability to develop avionics architecture that allow utility spacecraft component made by different vendors to communicate seamlessly with an application
 - Implementations and architectures can be independent between entities (because of ITAR, etc.) but can communicate with same components
- Reuse of software device drivers

How SpaceWire fits in

- Data Link layer protocols need to support device discovery algorithms for PnP
- SpaceWire currently has no formal mechanism to perform device discovery
- SpaceWire device discover mechanism would also have to support the ability to read the device description (probably XTEDS) from the component
 - Device description stored in non-volatile memory in component

SpaceWire PnP Status

- An Experimental packet based protocol using Protocol Identifier was developed and implemented by AFRL (for PnP Sat) and NASA (in lab)
- ESA has experimented with RMAP using features in Atmel 8X router to perform device discovery
- JAXA (Takahiro Yamada) proposed using Remote Memory Access Protocol (RMAP) as a standard method for performing network management like Simple Network Management Protocol (SNMP) is used to control and monitor a Management Information Base (MIB)
 - this method should be pursued as the mechanism for device discovery.
 - also provides ability to standardize the configuration space
- AFRL would like to keep asynchronous message notification feature (from router) that is in the packet based experimental protocol
 - when link on router becomes detached send a message to subscribers

SOIS and SpW WG Collaboration

- SOIS needs the SpW WG to define it's mechanism for device discovery
 - Recommend using RMAP and defining a MIB
- SOIS needs to study/prototype XTEDS and work with AFRL to modify XTEDS to meet SOIS requirements (in process)
 - SOIS requirements will be defined by use cases (see backup)
- SOIS also needs to work with XML Telemetry Command Exchange (XTCE) WG (see backup) so that XTEDS can be automatically translated to XTCE (for ground segment)

End.
Thank you

Backup

- XTEDS Use Cases
- XTEDS vs. XTCE

XTEDS Use Cases

Jonathan Wilmot

Device Normalization

- Run Time
 - For each class of device, star tracker, rate sensor, ...
 - On system initialization, on board software reads device data parameters from device
 - Uses data parameters to convert data into standard normalized values for run time algorithms
 - Allows devices of the same class to be substituted with true run-time PnP
- Compile Time
 - For each class of device, star tracker, rate sensor, ...
 - Development tools read system configuration file that references device data parameter file
 - Tools use data parameters to autocode conversion algorithms and compile link into software load
 - Allows devices of the same class to be substituted during development time with minimal schedule impact

Command & Telemetry

- Control center databases can be generated with XTEDs data
- Run Time
 - Device is queried and data sent to the control center
 - Tools use data parameters auto update control center database
 - Supports true run-time PnP of devices for commands and telemetry
- Compile Time
 - Development tools read system configuration file that references device data parameter files
 - Tools use data parameters auto update control center database
 - Allows devices to be substituted during development time with minimal schedule impact
- **Note that Command & Telemetry also applies to consoles and displays for crewed systems**

XTCE vs XTEDS

Brief Intro, features, criticisms

Kevin Rice Sept 09

What is XTCE

- CCSDS and OMG Standard
- Describes aspects of telemetry stream necessary for ground segment decommutation
- Describes aspects of command stream necessary for ground segment commutation (of cmds)
- XML Schema
- Format neutral (generalized: CCSDS, or major/minor frames, etc...)
- Specific focus for CCSDS missions is on:
 - Describing packet format (headers) and time stamps and packet body
 - Describing individual parameters in the packet body and how to convert them on the ground to a data type ready for further processing
 - Assume NO meta data in the data, you get bits – the ground needs additional info to successfully process
 - Describing additional aspects of TLM parameters common on the ground segment side
 - Limits, etc...
 - Describing how a command, it's associated packet and arguments go together
 - Describes how a user argument turns into a command packet item
 - Describe how additional items are in the command packet that the user does not usually see (checksum, etc...)
 - Describe command aspects such validity, priority, side effects and so forth unique to commanding
- Intended to be used as an EXCHANGE mechanism
 - Not replace native formats but map native formats to XTCE for common use among mission team members
 - Or larger community
 - Communities must agree on "how they do things", otherwise some % of info loss

XTCE Criticisms

- Very large schema
 - Many use cases captured as industry common practice
 - Most institutions only need subset
 - Many vendors tied to specific institutions
 - Large feature set scares implementers
 - Most institutions used to how they do things only
 - Little appreciation for variances in greater industry
 - (but often some unique feature to them missing as it's not common practice, results in criticism)
- Some syntax choices may be overly complicated
 - Certain items require additional implementation beyond parsing the XML and reading the info
 - Drives up cost
- Potential for large files size scares some
- Annotation incomplete in Schema itself
 - But we now have the CCSDS Magenta Book Core Ref. Guide
- Ambiguous in places
 - Certain items appear to allow constructions that do not make sense
- Due to large size, less industry commonality than one would think, need for reports to constrain usage by community makes it harder to adopt

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XTEDS Criticism

- No documentation
- Variable construction is ambiguous
 - Not clear which combination of attributes and elements is legal, many to choose from
- Does not completely describe what's on the "wire"
 - No bit or byte order
 - Does a poor job of describing relationship of wire bits to receiving side's data type
 - A int32 count with a Curve is a float to the receiver after processing
 - Have to derive that depending which features are set
- Message construct high-level, may be too minimal
 - Assuming variables are packed, one after the other
 - Can't describe gaps or addressing if needed
 - No way to specifically call out a header for example, messages cannot refer another, only variables
- No time based data types
- Describes Interface, it's messages and what's in them to a point
 - No behavior
 - Which Message means off?
- Generally, may simply be missing items that should be there for a broader user base